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RESEARCH ARTICLE

PREVALENCE OF VITAMIN A DEFICIENCY IN SCHOOL CHILDREN AGED 8-10 YEARS IN TIRUPATI

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ABSTRACT

Although a national vitamin A prophylaxis programme has been in operation for more than three decades, vitamin A deficiency (VAD) continues to be a major nutritional problem of public health significance in India. The present study was carried out with the aim of assessing the prevalence of clinical VAD among school going children 8-10 years in Tirupati. A study was carried out in area of Tirupati during 2008-2009. A total of 776 school children were examined for the presence of signs and symptoms of VAD. The total sample (776) of them was used to estimate blood vitamin A levels. The intakes β-carotene containing foods of plant origin such as GLV were also found to be lower than the RDA. Thus, the quality and quantity of foods consumed is reflected in the low biochemical levels of vit-A resulting in a high prevalence of deficiency. It is observed that about 56 percent of school age children of the present study had mean serum vit-A levels <30 µg/dl indicating borderline VAD state. Further categorization of participants into different degrees of VAD reveal that about 38 percent were having levels of vit-A in the high risk range of 20-30 µg/dl and about 22 percent were deficient with levels < 20 µg/dl. A high percent of girls (20.1) were severely deficient when compared to boys (13.7). Combining the different levels of deficient states, boys and girls showed a high prevalence of VAD (53.8 and 56.7 respectively), with a little difference between them. As age increased the severe deficiency is decreased. Increased vitamin A supplementation, health and nutrition education and consumption of vitamin A rich foods are essential to prevent VAD.

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INTRODUCTION

Vit-A is considered to be an essential micronutrient for epithelial differentiation and maintenance processes, and is well known because of the negative effects of deficiency. Research has demonstrated that, in addition to affecting the visual cycle, vitamin-A deficiency is directly linked to reproduction, fetal development, the immune system and to regulation of cell proliferation and differentiation (Biswas *et al.*, 2000). VAD can occur in individuals of any age. However, it is a disabling and in considered as a potentially fatal public health problem for children under 6 yrs of age. VAD related blindness is most prevalent in children less than 3 yrs of age. This period of life is characterized by high requirements for vitamin-A to support rapid growth, and the transition from breast feeding to dependence on other sources of the vitamin (Sommer, 1994). There is no consistent, clear indication in humans of a sex differential in vitamin-A requirements during childhood. Growth rates, and presumably the need for vit-A, from birth to 10 yrs for boys are consistently higher than those for girls (WHO, 1995). VAD is a major public health problem with the most vulnerable being preschool children and lactating and pregnant women in low-income countries (WHO, 1996). In children, VAD is the leading cause of preventable visual impairment and blindness. An estimated 2, 50,000 to 5, 00,000 children become blind every year due to VAD, with around half of whom die within a year of becoming blind (Sommer and West, 1996). VAD affects less than 30 percent of the global population (WHO, 2001), the most vulnerable groups are women of reproductive age, infants and children (West, 2002), the same age groups at highest risk for anemia. A cross-sectional study was carried out and the data were analyzed for 824 (61.5 percent) of 1339 (6-9 yrs) children for whom there was complete information on biochemical vit-A status, dietary vit-A intake, ocular examination for xerophthalmia, and anthropometry. The prevalence of xerophthalmia was 5.8 percent serum retinol levels were below 0.35 µmol/l and between 0.35 and 0.70 µmol/l in 8.4 and 51.1 percent of children respectively. The liver vit-A reserve (modified relative dose response ratio

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≥0.06) was low in 41.0 percent of the children. The high prevalence of severe VAD in children aged 6-9 yrs indicates the need to re-evaluate the practice of targeting vit-A supplementation programmes on children under 6 yrs of age in areas where VAD is endemic (Kassaye *et al*., 2001). VAD is most common in populations consuming most of their vitamin-A needs from provitamin carotenoid sources and where minimal dietary fat is available (Mele *et al*., 1991). About 90 percent of ingested preformed vit-A carotenoids varies widely, depending on the type of plant source and the fat content of the accompanying meal. Where possible, an increased intake of dietary fat is likely to improve the absorption of vit-A in the body. In areas with endemic VAD, fluctuations in the incidence of VAD throughout the year reflect the balance between intake and need. Periods of general food shortage and specific shortages in vit-A rich foods, coincide with peak incidence of VAD and common child hood infectious diseases e.g. diarrhea, respiratory infections, and measles. Seasonal food availability influences VAD prevalence directly by influencing access to pro-vit-A sources (Marsh *et al*., 1995). Direct measurement of concentrations of vit-A in the liver (where it is stored) or in the total body pool relative to known specific vit-A related conditions would be the indicator of choice for determining requirements. This cannot be done with the methodology currently available for population use. There are several more practical biochemical methods for estimating sub-clinical vit-A status but all have limitations (Underwood, 1990; Olson, 1992).

Blood levels between 0.35 and 0.70 µmol/1 are likely to characterize sub-clinical deficiency, but sub-clinical deficiency may still be present at levels between 0.70 and 1.05 µmo/l and occasionally above .05µmol / l (Flores *et al*., 1984). The safe level of intake for an individual is defined as the average continuing intake of vit-A required to permit adequate growth and other vit-A dependent functions and to maintain an acceptable total body reserve of the vitamin. This reserve helps offset periods of low intake or increased need resulting from infections and other stresses. Useful indicators include a plasma retinol concentration above 0.70 µmol/1, which is associated with a relative dose response below 0% or a modified relative dose response below 0.06. For lactating women, breast-milk retinol levels above 1.05 µmol/l are considered to reflect minimal maternal stores because levels above 1.05µmol/l are common in populations known to be healthy and without evidence of insufficient dietary vit-A (Newman, 1994). The review on VAD reveals that a majority of research has been focused on the children in the preschool yrs. Sommer *et al*. (1980) pointed out the fact that there is little information regarding the health consequences of VAD in school-age children. The prevalence of Bitot's spots (i.e. white foamy patches on the conjunctiva) may be highest in this age group but their occurrence may reflect past more than current history of VAD.

MATERIALS AND METHODS

The study was focused on the 8, 9 and 10 yr age groups as both genders exhibit a steady growth performance during these years. All the children attending the 9 MUP schools belonged to low income group. Children who were attending school from home were chosen in order to focus on the nutritional status of those in the family environment. None of the children wee ingesting any synthetic vitamin and mineral supplements. Thus, 776 children in the age range of 8-10 yrs and attending school regularly were the participants of the study. The investigation comprised of the dietary, clinical and biochemical methods. Nutrient intake was assessed through a combination of twenty four hour recall and weighment method. The dietary intake data were compared with the RDA (ICMR, 2007) suggested for the select age groups to focus on specific nutrient deficiencies at the intake level. A fasting venous blood sample was taken to measure the serum retinol (Oser, 1968).

RESULTS

The plasma vit-A status of the children is presented in table no1. It is observed that approximately 17.3 per cent of the total number of school children assessed (134 out of 776) had deficient levels (<20µg/dl) and 38.1 per cent (296 out of 776) had low levels (20-30µg/dl) of vit-A. The age wise distribution of vit-A levels reveal that with the increasing age with the exception of 10 yrs boys the serum vit-A levels showed an increase. In the age group of 8 yr a higher per cent (23.6) were having deficient levels when compared to 9 (16.8) and 10 yrs (12.6) children. The per cent of children having low vit-A serum levels was higher in 10 yrs (42.4) when compared with 9 (38.9) and 8 (32.0) yrs old children. The data presented in Table 1 reveal that 53.8 percent of boys and 56.7 percent of girls were having serum vit-A levels in the deficient range. Further distribution of children based on different levels of vit-A as deficient, low and acceptable status is presented in Table 1. It is observed that among boys 13.7 were deficient (<20 µg/dl) and 40.1 percent were having low (<20-30 µg/dl) levels of vit-A. The remaining 46.2 percent boys were in acceptable levels of vit-A (30 µg/dl). With regard girls it is evident that 20.1 percent were observed to be in deficient range, followed by 36.6 percent in the low level. The acceptable serum levels of vit-A were found in 43.3 percent of girls. The percent prevalence of signs and symptoms of different nutritional deficiency states of children is presented in Table 2.

Table 1. Prevalence of VAD among school going children

Status	Boys				Girls				Grand Total %(N)
	8yrs %(N)	9 yrs %(N)	10 yrs %(N)	Total %(N)	8yrs %(N)	9 yrs %(N)	10 yrs %(N)	Total %(N)	
Deficient (<20µg/dl)	21.9 (21)	12.1 (14)	9.2 (12)	13.7 (47)	24.8 (32)	20.1 (33)	15.6 (22)	20.1 (87)	17.3 (134)
Low (20-30 µg/dl)	33.3 (32)	40.5 (47)	44.6 (58)	40.1 (137)	31.0 (40)	37.8 (62)	40.4 (57)	36.6 (159)	38.1 (296)
Acceptable (>30 µg/dl)	44.8 (43)	47.4 (55)	46.2 (60)	46.2 (158)	44.2 (57)	42.1 (69)	44.0 (62)	43.3 (188)	44.6 (346)

Table 2. Percentage prevalence of clinical signs of nutritional deficiencies among school children

Nutrient Deficiency	Clinical status	Boys				Girls				Grand total
		8 yrs	9 yrs	10 yrs	Total	8 yrs	9 yrs	10 yrs	Total	% (n)
		% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	% (n)	
Vit-A	Conjunctival xerosis	31.3 (30)	21.6 (25)	22.3 (29)	24.6 (84)	26.4 (34)	26.8 (44)	28.4 (40)	27.2 (118)	26.0 (202)
	Bitot's spots	20.8 (20)	16.4 (19)	18.5 (24)	18.4 (63)	17.1 (22)	20.7 (34)	19.1 (27)	19.1 (83)	18.8 (146)
	Corneal xerosis	26. 0 (25)	25.9 (30)	20.0 (26)	23.7 (81)	23.3 (30)	25.6 (42)	20.6 (29)	23.3 (101)	23.5 (182)

Table 3. Mean daily nutrient intake of school going boys and girls as compared against RDA

Nutrients	8 Years[1] [2]		9 Years[1 2]		10 Years[1 2]	
	RDA▪	Mean±SD	RDA▪	Mean±SD	RDA▪	Mean±SD
Boys Retinol(µg)	600	149.6±17.9**	600	180.9±42.5**	600	245.5±48.3**
Girls Retinol(µg)	600	137.4±19.2**	600	175.5±37.5**	600	230.2±18.0**

** Significant at p<0.01
[1] Difference between age groups significant at p<0.01
[2] Difference between genders significant at p<0.01
▪ ICMR (2007)

Out of 776 children examined, 530 children (68.3 percent) were found to be having different signs and symptoms of VAD. The presence of conjunctival dryness (26 percent), Bitot's spots (18.8 percent) and corneal xerosis (23.5 percent) indicates the presence of VAD.

Retinol

The mean retinol intake of boys aged 8, 9, 10 yrs was 149.6, 180.9 and 245.5 µg respectively. The mean intake of girls at 8, 9, 10 yrs was observed to be 137.4, 175.5 and 230.2 µg respectively. The RDA for boys and girls is 600 µg for 8 to 10 yrs. When compared with RDA the intakes were lower at all ages for both genders. Percent deficit of retinol intakes were ranging from 75 to 59 for boys and 77 to 62 for girls.

DISCUSSION

The preceding discussion has pointed to the fact that the dietary intakes of vit-A of children were less than half of the requirement. Further, the lower frequency of consumption was observed for foods of animal origin like eggs and milk that contain vit-A. In addition the intakes β-carotene containing foods of plant origin such as GLV were also found to be lower than the RDA. Thus, the quality and quantity of foods consumed is reflected in the low biochemical levels of vit-A resulting in a high prevalence of deficiency. It is observed that about 56 percent of school age children of the present study had mean serum vit-A levels <30 µg/dl indicating borderline VAD state. Further categorization of participants into different degrees of VAD reveal that about 38 percent were having levels of vit-A in the high risk range of 20-30 µg/dl and about 22 percent were deficient with levels < 20 µg/dl. A high percent of girls (20.1) were severely deficient when compared to boys (13.7). Combining the different levels of deficient states, boys and girls showed a high prevalence of VAD (53.8 and 56.7 respectively), with a little difference between them. As age increased the severe deficiency is decreased. The prevalence of VAD in northern Ethiopia among 824 school-age children reported a xeropthalmia rate of 5.8 percent. Serum retinol concentrations were deficient in 8.4 and low in 51.1% of the children. A significant difference was noted between sexes only in vit-A reserves; girls had significantly lower vit-A reserve than boys (Kassaye *et al*., 2001). These findings are similar to those of the present investigation. Although there exists substantial documentation of prevalence, severity and health consequences of VAD in preschool-aged children (Sommer and West, 1996), and rapidly emerging evidence about this nutritional problem in pregnant and lactating women (West, 2002), little has been done to evaluate systematically the extent of VAD in the preadolescent and adolescent years. The preadolescent school-aged individuals, as a demographic group, are widely regarded as having relatively lower health and nutritional risks. This lower risk profile has likely depressed motivation historically to assess the prevalence of VAD and its disorders or to implement VAD prevention programs in school-aged children. Indeed, the public health consequences of preadolescent VAD, other than mild manifestations of xerophthalmia, remain largely unknown.

While blinding xerophthalmia seems to be exceedingly rare, other less apparent or specific health consequences of VAD known to exist in younger children, such as increased serverity of diarrhea (Sommer and West, 1996), could contribute to the burden of disease in this age group and should not be assumed to be absent. Very few data were available to estimate the prevalence or burden of school-aged VAD in other regions of the world during the early 1990's. To fill the gap WHO, (1995) reviewed the published and unpublished data on available on VAD among children in South-East Asian Region. The review suggests that least one-quarter of all school-aged children, or nearly 83 million in the region were VAD, defined as having a serum retinol concentration below 0.70 µmmol/l (20 mg/dl). It was further estimated that 10.9 percent or 9 million, of deficient children have mild xerophthalmia (night blindness or Bitot's spots), equivalent to an overall prevalence of 2.6%. Interestingly, both prevalence estimates for VAD and xerophthalmia, exceed public health minima of 15 and 1.5 percent, respectively, as established by the WHO and the

International Vit-A Consultative Group (IVACG) for identifying VAD as a public health problem in preschool-aged children. Until modification is warranted, these cutoffs also are considered applicable to children 5-15 yrs of age. Population surveys or community based studies carried out in the Senegal (Carlier *et al*., 1993), Cameroon (Gouado *et al*., 1996), Malawi (Brabin *et al*., 1999), Ethiopia (Kassaye *et al*., 2001), and Tanzania (Ash *et al*., 2003) have revealed prevalences of 0.5-6 percent for xerophthalmia and 13-60 percent for VAD (0.70 µmol/l). The prevalence rates observed among children of low-income countries till the recent past and the percent prevalence observed among the school attending children points to the fact that no matter what interventions were implemented the magnitude of the sub-clinical form of VAD still exists as a public health problem. Gopalan (1994) opined that the era of gross and rampant VAD leading to blindness is past in India. However, there is a great need to control the existing sub-clinical form of VAD in the context of its far reaching consequences of mortality and morbidity.

Furthermore, several researchers suggest that VAD in early adolescence antecedes and predicts chronic maternal VAD and its apparent health consequences (Christian *et al*., 1995, 1998, 2000a, b, 2001; West *et al*., 1999). This focuses on the need to quantify the prevalence and severity, and understand the epidemiology of VAD in early adolescence in terms of prevalence; both clinical and sub-clinical among children of 5-15 yrs of age. A prevalence of 34 percent was reported among school attending adolescents in Nigeria (Ene-Obong *et al*., 2003). These data and data of the present study suggest that VAD could be a significant public health problem. In the present study the data is pertaining to those children hailing from low income families; thus the high prevalence may be attributed to this aspect. This also points out to the need for data from a representative population. The data on provisional estimates suggest that school-aged VAD could be an important public health problem in the South-East Asian region due to the numbers of children likely affected, the potential for associated but largely ignored (and unknown) health consequences at this age and because of the potential for deficiency in early adolescence to predispose women to chronic vit-A deficiency disorder during the reproductive years, especially during and following pregnancy.

An assessment of the vit-A status of school children in Tanzania, Ghana, Indonesia and Vietnam found that VAD was a severe public health problem in Tanzania (30% deficient in vit-A), a moderate problem in Ghana and a mild problem in Indonesia and Vietnam according to WHO criteria (Friis *et al*., 1997). A study of the effect of providing fortified soup to school children in South Africa found that between 23.7 and 46.7 percent of children were marginally vit-A deficient (<30µg/dL) (Venberg *et al*., 1997). In addition to the existence of a positive relationship between VAD and malnutrition, as evidenced through a relation between plasma vit-A levels and inadequate nutritional status, the problem also may be precipated by helminthes infestations and infections. A study of the relationship between serum retinol concentrations and helminth infection among primary and pre-school children in South Africa found that 23.5 had low serum retinol concentrations Veknci a *et al*. (1999).

In the present context there is a positive relation observed between serum vit-A levels and malnutrition state; the SW group recorded low serum vit-A levels than the S group children. It is possible that the children being from poor environments may have helminth burden contributing partly to VAD. In cameroon, a study of the relationship of the effect of the parasite, onchocercia volvulus on plasma vit-A levels in 261 school children reported sub-clinical VAD in over 80 percent of the children. Children with onchocerciasis had significantly lower vit-A concentrations compared to children without infections (Zambou *et al*., 1999). The significant improvements observed in the vit-A levels and micronutrients in general may be partly attributed to the deworming of the participants of the study earlier to supplementation programme. Ferraz *et al*. (2005) reported that VAD is common among populations of low socioeconomic status, and appears that it is not only to be associated with low levels of consumption of foods containing vit-A, but also with lack of information on healthy nutrition. In these circumstances, prevention by means of supplementation with vit-A could reduce the rates of this deficiency over the short term, while guidance on choosing a healthy diet, including sources of carotenoids and vit-A, could bring results over the medium and long term. Working together to improve awareness of the issue, the teachers of infant and primary schools can play an important role promoting a wide-ranging, informative and explanatory compaign to achieve safe and healthy nutrition. In the current study the school children are from low income group and not only low inclusion of vit-A rich foods, but also ignorance might have contributed to the magnitude of VAD.

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